Eskişehir Osmangazi University - Electrical Engineering Department Fundamentals of Control Systems Second Midterm Examination - Spring 2007

 A linear time invariant system is described by the transfer function ^{Y(s)}/_{X(s)} = ⁵/_{s²+3s+10}. Let the unit step input be applied to this system.

 a. Find the steady state value y_{ss} of its output.
 b. Find the first time it reaches y_{ss}
 c. Find the time it reaches its first peak value.

 Let p(s) = s⁶ + 4s⁵ + 3s⁴ + s³ + 6s² + 3s + 4. How many roots of p are in the left half complex plane. Show your work.
 Let G(s)H(s) = ^K/_{(s+1)(s+2)(s+3)}, K > 0. Is the point s = i4 on the root locus for some K? Show your work.

A. Karamancıoğlu

Solutions

1. The transfer function could be written as

$$\frac{Y(s)}{X(s)} = \frac{1}{2} \frac{10}{s^2 + 2\frac{3}{2\sqrt{10}}\sqrt{10}s + 10}$$

which shows that $w_n = \sqrt{10}$ and $\xi = \frac{3}{2\sqrt{10}} = 0.4743$. Therefore, a) $y_{ss} = 0.5$ b) $t_r = \frac{\pi - \beta}{w_d} = \frac{\pi - 1.0766}{2.7839} = 0.7417$ sec. c) $t_p = \frac{pi}{w_d} = \frac{\pi}{2.7839} = 1.1284$ sec. 2. Γ 1, З, 6, 4] [4, 1, З, 0] 11/4, 21/4, Γ 4, 0] -73/11, -31/11, 0, [0] Ε 298/73, 4, 0, 0] [549/149, 0] 0, 0, Γ 4, 0, 0, 01

Two sign changes; therefore, two in the RHCP and four in the LHCP. **3.**

$$\frac{K}{(1+i4)(2+i4)(3+i4)} = 0 - \{|\underline{1+i4}| + |\underline{2+i4}| + |\underline{3+i4}\} = 0 - \{75.96^0 + 63.43^0 + 53.13^0\} = -192.52^0 - 192$$

It is not an odd multiple of 180° , therefore, it is not on the root locus.